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PREDATORY POTENTIAL OF ARANEAE AGAINST APHIDIDAE PESTS IN CANOLA CROP

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ABSTRACT

The dominant spider species of order Araneae include *Oxyopes javanus* (Family Oxyopidae), *Araenidae spp.* (Family Araenidae), *Pardosa oakleyi* and *Hippasa partita* (Family Lycosidae) at cotton-wheat zone were studied for their predatory potential against three aphid species of canola crop under laboratory experiment. For laboratory experimentation, three species of aphids viz. *Lipaphis erysimi, Myzus persicae, Brevicoryne brassicae*, and worms were used. The results showed that spider consumed all the preys with different proportions offered in multiple and single prey feeding experiments. *Oxyopes javanus* was ravenous predator followed by *Aranidae spp.* on foliage and *Pardosa oakleyi* and *Hippasa partita* on ground with female consumed high number of preys as compared to male. Field observation showed seasonal variation in aphid population which in turn affect the diet of predators. The present study suggest that dominant spider species consumed aphids when they are at peak which may help in containing aphid population and this results in successful pest management in canola crop.

Key words: Canola, Aphids, Spiders, Predator, Pest.

INTRODUCTION

Members of Araneae are the dominant generalist predators with euryphagous feeding habits in most of the agro-ecosystems which play a basic role in containing phytophagous insect pest populations (Symondson *et al*., 2002; Nyffeler and Sunderland, 2003). Their diversified feeding habits enable them to stay in the crop field when the prey density is low. A euryphagous predator shows functional and numerical response to its prey and does not rely on specific feeding (Hole *et al.,* 2005). Zoophagous population always affects the phytophagous members mainly in the season of increased predation (Carter and Rypstra, 1995). For spider the cannibalistic behavior and intra guild predation facilitates pest from predation pressure and increase their abundance in the crop fields (Synder and Ives, 2001).

Majority of spider species prefer a habitat where the food is abundant (Harwood *et al*., 2003). They maximize their fitness by optimal balancing of nutrients rather than by maximizing of energy consumption (Toft, 1999). In the presence of diversified food, priority of a predator for a specific prey may based on prey type and availability in the feeding ground while age, size, habitat structure and weather conditions are also important (Pitt and Ritchie, 2002). However, the prey consumption in term of weight and proportions is not constant between instars and within an instar. To attack and engulf a live prey is easier at earlier stages as compared to later ones (Isikber and Copland, 2001). The food consumption also changed with the past experience and internal state of a spider (Toft, 2005).

Canola cultivations are available on large scale in Punjab and face heavy aphid attack at the peak of crop season. Three species of aphids *viz*., *Lipaphis erysimi, Myzus persicae* and *Brevicoryne brassicae* attack canola crops of this area in addition to jassids, thrips and plant hoppers as described by Hashmi *et al*. (1983). Alterations in farming practices are also responsible for increased loss by pests due to development of high resistance strains. As a result crop yield decreased and impact can be clearly observed in term of quality and quantity (Sharma *et al.,* 2002; Khattak *et al.,* 2007). The ecological predatory complex of our agro-ecosystems is dominated by many arthropods and spiders are the prominent member of this complex with their specific role. The aim of present work was to analyze the efficiency of spiders against aphids in canola crop and feeding experiments offered with single and multiple prey species were helpful in determining the quantitative aphid consumptions by spiders in laboratory conditions. The comparative account of field and laboratory observation facilitates in determining a better biological control and its implementation against these economic pests.

MATERIALS AND METHODS

Four species of spiders, three species of aphids and worms were abundant round the season in canola field especially in cotton-wheat zone, thus selected for the experimental work (Dosdall, 2013). The adult spiders both from (foliage and ground) were collected alive from the canola fields using sweep nets and automated sifters. The specimens were kept at ideal room temperature 27°C, 55-65% humidity and a light a dark cycle of 14:10 h. For predatory potential estimation nymph and adult of *Lipaphis erysimi, Myzus persicae, Brevicoryne brassicae*, while Ist and 2nd instars of worms were used as prey. The pest species were obtained from nursery of the university on daily basis for feeding.

Before experimentation, the spiders were starved for 72 hrs, placed in jars of (9 cm height and 3cm diameter) and one species of prey was offered in excess (12 specimens) to each predator. For each trial (offered single prey species), 10 spiders of each species were used and the practice was repeated thrice at different time. The jars were examined on daily basis and number of dead preys present was recorded. In control group similar number of preys was kept without any predator. In feeding trial offered with multiple prey species, similar strategy was used with exception of the provision of all types of preys to each predator. Twelve specimens were presented in equal ratios of all types and dead specimens were counted.

For field observations, three fields of canola crop (non-treated with pesticides or insecticides) were randomly selected and observed on daily basis for a period of two months at peak crop season. The spiders were diurnal in feeding habits therefore; the observations were conducted for 5 hrs in a day with 3 hr interval from (6:00am-6:00pm). In case a predator was found with live or dead prey, the prey species was identified upto order level. Similarly the aphid abundance was calculated from randomly selected 20 tillers in the field and number of aphids per tiller was counted. The nature of data was checked by Kolmogorov–Smirnov test. The difference of predatory potential of each spider species for both single and multiple prey feeding trial was analyzed by ANOVA. The difference in the feeding preferences of male and female spiders was checked using paired *t*- test.

RESULTS

The feeding trial conducted in laboratory showed that spiders preyed on all types of preys offered with different proportions. Overall, nymph of three aphid species and Ist instar of worms were the favourite food of all predators in single prey offered feeding trial. *O. javanus* consumed *M. persicae* nymph and worms in high proportions while *B. brassicae* and *L. erysimi* nymphs were consumed in almost equal ratios. *Aranidae spp.* preferred *L. erysimi* over *M. persicae* and *B. brassicae* nymphs. *P. oakleyi* consumed worms in excess followed by *M. persicae* and *B. brassicae* nymphs in equal ratios and *L. erysimi* were least preferred while *H. partita* also consumed worms in excess followed by *B. brassicae* and *M. persicae* nymphs. *L. erysimi* were least preferred (Table 1 & 2). Generally the prey consumption by female predator was higher than male partner (Table 1 & 2).

Overall a significant low consumption of all prey species was recorded in feeding trial offered with multiple prey as compared to trial offered single prey. *O. javanus* consumed nymph of *L. erysimi* in high proportion followed by *M. persicae* and *B. brassicae* whereas, worms were least preferred. *Aranidae spp. P. oakleyi* preferred *L. erysimi* and *M. persicae* followed by worms and *B. brassicae* nymphs were least favoured while *H. partita* preferred worms and *B. brassicae* nymphs were least favoured (Table 3 & 4). Once again the prey consumption by female predator was higher than male (Table 3 & 4).

Observations with direct prey capture display in the crop field recorded 102 specimens of (*O. javanus*), 95 (*Aranidae spp.*), 78 (*P. oakleyi*) and 72 (*H. partita)* specimens. The predators were brought to laboratory for prey identification in their chelicerae. It was noticed that majority of prey consumed in the field belonged to order Homoptera, Collembola, Coleoptera, Diptera, Lepidoptera and worms of different species (Table 5). Although prey fluctuations were observed with the season (S=25.15, P=0.005 for *O. javanus;* S=19.35, P=0.007 for *Aranidae spp*., S=14.85, P=0.009 for *P. oakleyi* and S=13.98, P=0.008 for *H. partita*). During the extreme cold weather, collembola were the preferred food, coleopteran larvae and worms were consumed by sub adults while lepidoptera and diptera larvae were consumed by adults. All the aphids were preferred during the month of February and March as it was the peak season of different aphid population. However, no statistically significant variation was observed in monthly diet composition of different predators.

Table 1. Mean number of prey killed by female spiders after 24 h (offered single prey spp.).

Predator	*Lipaphis erysimi*		*Myzus persicae*		*Brevicoryne brassicae*		Worms	
Species	Nymph	Adult	Nymph	Adult	Nymph	Adult	Ist inst	2nd inst
Oxyopes javanus	5.2±0.3	4.7±0.7	6.3±0.4	5.4±0.6	5.1±0.6	4.2±0.3	7.7±0.3	6.7±0.2
Aranidae nymph	8.5±0.5	6.5±0.4	7.8±0.2	7.5±0.3	7.7±0.8	7.1±0.4	5.2±0.6	4.9±0.4
Pardosa oakleyi	3.9±0.2	3.3±0.7	5.8±0.5	5.0±0.7	5.6±0.4	5.1±0.6	6.7±0.4	6.4±0.8
Hippasa partita	3.2±0.4	3.1±0.5	4.8±0.3	4.8±0.5	5.1±0.7	4.5±0.5	6.0±0.5	5.8±0.3

Table 2. Mean number of prey killed by male spiders after 24 h (offered single prey spp.).

Predator	*Lipaphis erysimi*		*Myzus persicae*		*Brevicoryne brassicae*		Worms	
Species	Nymph	Adult	Nymph	Adult	Nymph	Adult	Ist inst	2nd inst
Oxyopes javanus	4.0±0.3	3.5±0.7	5.2±0.4	4.9±0.6	4.3±0.6	4.1±0.3	6.9±0.3	5.7±0.2
Aranidae nymph	5.9±0.5	5.2±0.4	6.2±0.2	5.5±0.3	5.7±0.8	4.8±0.4	4.8±0.6	4.3±0.4
Pardosa oakleyi	3.3±0.2	2.8±0.7	4.3±0.5	3.7±0.7	5.0±0.4	4.1±0.6	5.4±0.4	4.2±0.8
Hippasa partita	2.9±0.7	2.5±0.5	4.1±0.6	3.2±0.3	4.5±0.6	3.8±0.4	5.2±0.7	3.8±0.5

Table 3. Mean number of prey killed by female spiders after 24 h (offered multiple prey spp.).

Predator	*Lipaphis erysimi*		*Myzus persicae*		*Brevicoryne brassicae*		Worms	
Species	Nymph	Adult	Nymph	Adult	Nymph	Adult	Ist inst	2nd inst
Oxyopes javanus	3.6±0.4	2.7±0.2	3.3±0.5	2.1±0.4	2.9±0.2	2.5±0.3	0.2±0.1	0.0±0.0
Aranidae nymph	4.2±0.6	3.4±0.8	4.0±0.5	2.2±0.8	2.7±0.3	1.0±0.3	3.9±0.2	2.7±0.2
Pardosa oakleyi	3.5±0.9	2.4±0.6	3.8±0.4	2.7±07	2.2±0.5	2.0±0.8	5.2±0.1	3.9±0.8
Hippasa partita	3.2±0.7	2.0±0.3	3.2±0.7	2.0±0.5	1.9±0.4	1.7±0.6	4.8±0.3	3.0±0.5

Table 4. Mean number of prey killed by male spiders after 24 h (offered multiple prey spp.).

Predator	*Lipaphis erysimi*		*Myzus persicae*		*Brevicoryne brassicae*		Worms	
Species	Nymph	Adult	Nymph	Adult	Nymph	Adult	Ist inst	2nd inst
Oxyopes javanus	5.6±0.4	3.7±0.2	4.3±0.5	4.1±0.4	3.9±0.2	3.5±0.3	0.3±0.1	0.0±0.0
Aranidae nymph	6.2±0.6	4.4±0.8	6.0±0.5	5.2±0.8	3.7±0.3	3.0±0.4	1.0±0.4	0.7±0.2
Pardosa oakleyi	5.5±0.9	4.3±0.6	4.8±0.4	2.9±0.6	3.1±0.5	2.6±0.8	1.2±0.1	0.9±0.8
Hippasa partita	4.8±0.7	4.0±0.3	4.2±0.5	2.3±0.5	2.7±0.4	2.2±0.5	1.1±0.3	0.7±0.5

Table 5. Percent composition of different orders as prey in canola crop fields.

Order	*O. javanus*	*Araneidae spp.*	*P. oakleyi*	*H. partita*
Collembola	22	35	2.5	2.0
Homoptera	35.3	28	22.8	18.8
Coleoptera	15.3	10.5	7.2	6.3
Diptera	20.2	14.5	18.8	15.3
Lepidoptera	4.5	5.2	3.5	2.8
Worms	33	28	25	20

DISCUSSION

The feeding range of four spider species was studied in laboratory as well as in the field and observed that they mainly feed on phytophagous insects which act as crop pest and cause heavy economic loss (Wise, 1993; Oelbermann *et al*., 2008). It is a general concept that, aphids were the favourite food for spiders during winter cropping season. Similar trend was observed in the present feeding trial where both nymph and adult stages of aphids were preyed by spiders (Rana *et al.*, 2012). Worms of different species were also consumed at different stages which clearly indicate that aphids are poor quality prey that allowed neither growth nor development of the spiders Toft and Wise (1999). The prey consumption was lower in feeding trial offered with multiple prey as compared to trial offered with single prey which provides a proof that feeding nature depend

on the seasonal fluctuation in prey population while such predators are generalist rather to be specific (Nyffeler and Sunderland, 2003).

Out of four species studied, two are foliage dweller while other two live on ground. The preys offered in lab trial consisted of aphids and worms which reside on leaves. But few of them fall on the ground and the predators easily feed on them (Nyffeler and Benz, 1988). Winder *et al*. (1994) reported that a large number of aphids falls on the ground and remain available to ground spiders. The phytophagous species use diversity of habitat within the agro-ecosystem thus, easily available to all predators either they are on leaves or on ground (Ruby *et al.,* 2011).

Observation in the field showed that spider feed on other species in addition to aphids. Larvae of order Diptera constitute a major part while collembola were highly preferred during extreme winter. Flies and larvae of Diptera are highly nutritious food for all spiders especially for foliage resident (Rana *et al.,* 2012). But the ground dweller species face a deficiency of nutrients when specifically feed on flies (Oelbermann and Scheu, 2009). The trend of collembola consumption is not a healthy sign for predatory potential in ground dweller spiders (Bilde *et al*., 2000). Regarding male and female partners, it was observed that female consume more quantity of prey as compared to males. The female required energy for oviposition, brood care and survival while male require energy to perform all necessary life activities. According to Walker and Rypstra (2001) the male spiders act as time minimizers while female as energy maximizers. The main burden for female members stands in term of reproduction which is obvious in the present case.

The prey-predator relationship or prey consumption by a predator cannot be compared in the laboratory and field conditions. High prey consumption rate was observed in feeding trial offered single prey at a time under laboratory conditions. Abiotic conditions include ambient temperature, wind velocity, relative humidity, light penetration and soil type vary greatly in the field and affect the animal life activities. The behavioural activities such as predator-prey encounter, suitable habitat availability, cannibalism, intra-guild predation and many other ecological correlates also leave an impact on prey-predator relationship (Rana *et al.,* 2012).

The present work proved that three species of aphids are known pest of canola crop and can be managed by introduction of spiders during peak crop season when aphid attack is very high. The spiders seemed helpful in consuming many pests in addition to targeted one even they are of no benefit for these generalist predators. A useful aspect of these predators is, that they shift their feeding strategy to an alternate source in the absence of a preferred prey in the field which is of prime ecological importance.

According to current study, dominant spider predators of canola crop at cotton-wheat zone include *Oxyopes javanus* (Family Oxyopidae), *Araenidae spp.* (Family Araenidae), *Pardosa oakleyi* and *Hippasa partita* (Family Lycosidae). Their predatory potential proved that known aphid pest of canola as *Myzus persicae* are the preferred prey followed by worms, *Brevicoryne brassicae* and *Lipaphis erysimi* under the laboratory conditions. However, order diptera on foliage and collembola on ground act as alternate food in the absence of aphids in field conditions.

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